The authors would like to thank the Anonymous Referee 1 for his/her valuable comments and suggestions to strengthen the analysis presented in our manuscript. The comments and suggestions have been taken into account in the revised manuscript, as follows (original referee's comments in bold):

This study used a biogeochemical model to examine effects of climate forcing biases in global climate reanalysis on carbon cycle predictions across a permafrost peatland thaw gradient. The main findings show that all peatland sites studied (bog, fen, palsa) remain carbon sinks, but that the bog and fen have a net positive radiative forcing because of high methane emissions. The study finds that climate responses can have major implications for carbon cycle dynamics in these systems. It is well written. Just a few comments below to help clarify some of the site descriptions, etc.

The authors thank the reviewer for the valuable comments. We have carefully revised our manuscript based on the suggestions provided by the reviewer to clarify some of the original descriptions.

Specific comments:

Line 63-69: what about the mass-balance studies from Alaska that suggest that a significant portion of the permafrost peat is lost upon thaw (O'Donnell et al., 2014 Ecosystems, Jones et al., 2016 Global Change Biology).

O'Donnell et al. (2012) and Jones et al. (2017) have been included in our revised manuscript (Lines 66-71) to improve our description of permafrost peatland carbon vulnerability under a changing climate.

Line 135-136: The seasonality of precipitation could be important. Is there information on whether its increased snowfall/depth (which could also warm soil temperatures)?

The precipitation measured at ANS did not show a significant change in precipitation seasonality throughout the years. Precipitation magnitude and variability during summer are generally greater than during winter (Figure 3b). The analysis presented by Malmer et al. (2005) showed that monthly mean snow depth in 1986-2000 was greater than in 1957-1970, suggesting that it is possible that increased annual precipitation (Figure 2b) can be associated with increased snowfall in winter and spring. Unfortunately, we do not have continuous snowfall or snow depth measurements to compare with the changes in precipitation.

Study site description: has anyone studied the history of permafrost at this site (i.e., when it formed) and whether permafrost aggradation occurred syngenetically with peat accumulation? I would argue that this information is important in carbon dynamics with thaw.

Inception of peat deposition at the Stordalen Mire has been dated at around 6,000 calendar years before present (cal. BP) (Sonesson 1972) in the southern part of the mire and at around 4,700 cal. BP in the northern part (Kokfelt et al., 2010). Kokfelt et al. (2010) suggested that permafrost aggregation initiated during the Little Ice Age (around 120-400 cal. BP) in the Stordalen Mire.

We agree with the reviewer that permafrost history of the study site could be important in carbon dynamics with thaw. However, such information may not affect our analysis because we did not attempt to simulate permafrost aggradation/degradation history in this study. Instead, we simulate the palsa, bog, and fen sites individually and discuss the differences shown in different thaw stages. We did, however, add the peat and permafrost history information to the site description (Lines 146-150).

Line 161: italicize Sphagnum

Sphagnum has been italicized as suggested by the reviewer (Line 171).

Line 173: It is unclear if the measurements described in this paragraph were conducted in this study or if the authors are reporting on measurements made by Bäckstrand et al. Perhaps that can be clarified at the beginning of this paragraph

The measurements described in this paragraph were made by Bäckstrand et al. (2008b). A proper citation has been added at the beginning of this paragraph (Line 184).

Line 174-175: "chamber lids were removed in the Fall": Fall can be lowercase (as can spring, here and elsewhere; you don't capitalize "summer" later in the text). Can you be more specific about "fall" and "spring"? How closely did the measurements coincide with freeze-up and thaw? Which months? Do you suspect that there are winter emissions? How many chambers/peatland type? Do you have any idea when the fen and bog thawed (i.e., 5 years ago, 500 years ago, 1000 years

ago) and when peat started accumulating at these sites? These could have important implications for emissions and the carbon balance of a peatland.

All seasons have been converted to lowercase in the revised manuscript. We have revised the original sentence with some clarifications for the measurement period (Lines184-188). We believe that winter emissions could contribute to the annual carbon budget, as suggested by our simulation results, but we don't yet have enough quality-controlled measurements in winter to verify our hypothesis. We don't yet know precisely when the fen and bog formed, but all three of the investigated peatland types were there before 1930's (based on Swedish military photography; information added to the site description (Lines 164-165)). As mentioned above, Kokfelt et al. (2010) suggested that peat inception took place at around 4,700 cal. BP (around 6,000 cal. BP by Sonesson 1972) in the Stordalen Mire and permafrost aggregation initiated during the Little Ice Age.

Line 365: how much does the water table fluctuate for the bog over the summer?

The simulated water table fluctuates from -7 cm to -1 cm (below surface) over the summer, as shown in Figure 6.

Line 408: "the higher CH4 emissions in the fully thawed fen can be attributed to its faster thaw rate": Do you mean rate of seasonal thaw or do you mean rate of permafrost thaw? If permafrost thaw, how do you know how quickly it thawed?

We meant the rate of seasonal thaw, not the rate of permafrost thaw. We simulated the seasonal thaw dynamics under three different permafrost thaw stages, and compared the seasonal thaw and carbon cycling across the permafrost thaw gradient. The original sentence has been revised as suggested by the reviewer (Line 421).

Section 4.1, ~line 415: in addition to ALD, do you know if there is a talik in any of these peatland types in the winter? Also, I don't understand why the "fully thawed fen" or the bog have an ALD, if they're thawed. Perhaps a conceptual diagram would help readers envision the differences in permafrost regime of these different peatland types, or at least clarification about what is meant by ALD in the "fully thawed fen" and bog. An additional table might be useful that includes information about total peat depth, active layer depths, average water table depths, surface vegetation communities, and perhaps some information on the number of chambers per site (and was just one feature per peatland type studied or did you study multiple?)?

The water table depth and ALD were only measured in the growing season, and we do not know if there is a talik in our study sites during winter. The confusing description (fully thawed fen) has been replaced with "fen" in the revised manuscript. The original terminology was chosen to match previous studies conducted at the same sites that qualitatively describes the permafrost thaw gradient across palsa, bog, and fen.

As suggested by the reviewer, an additional conceptual diagram (Figure 1) has been included in the revised manuscript to provide a qualitative summary of the three peatland types investigated in this study.

Line 481-482: Is the model dynamic? Is vegetation allowed to change as conditions change (wetter, drier), or did the model not run long enough for species changes to occur?

Vegetation is allowed to change with changing environmental conditions, and we noticed species changes among different model forcing climate conditions (results not shown). The *ecosys* model prognoses vegetation dynamics with internal resource allocation and remobilization, competition for light and nutrients, and different plant functional traits. Shifts in plant functional types were modeled through processes of plant functional type competition for light, water, and nutrients (nitrogen, and phosphorus) within each canopy and rooted soil layer. A qualitative summary of the *ecosys* model has been included in the supplemental material of this manuscript.

Reference

Kokfelt, U., Reuss, N., Struyf, E., Sonesson, M., Rundgren, M., Skog, G., Rosen, P., and Hammarlund, D.: Wetland development, permafrost history and nutrient cycling inferred from late Holocene peat and lake sediment records in subarctic Sweden, J. Paleolimn., 44, 327–342, doi:10.1007/s10933-010-9406- 8, 2010.

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